# ARL WITHIN THE OBJECTIVE FORCE

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## Introduction

The Army Research Laboratory (ARL) of the Research, Development and Engineering Command (RDECOM) is the Army's corporate basic and applied research laboratory. ARL consists of the Army Research Office (ARO) and six directorates: Weapons and Materials, Sensors and Electron Devices, Human Research and Engineering, Computational and Information Sciences, Vehicle Technology, and Survivability and Lethality Analysis. The Army relies on the ARL team for scientific discoveries, technologic advances, and analyses to provide warfighters with capabilities to succeed on the battlefield.

ARL has a rich history of providing research and technology for the Army. Predecessor organizations were responsible for many significant accomplishments such as the first digital computer, ENIAC (Electrical Numerical Integrator and Computer); the invention of the proximity fuze; and development of the photolithography process for integrated circuits.

## Today's Technology

Looking deep inside any system used by today's Army, one can see the results of ARL research. These results include highly lethal kinetic energy ammunition, the most effective advanced armor in the world for the Abrams tank, and the load-bearing pack and the Kevlar helmet for the individual soldier. Most recently, ARL has supported ongoing Army operations with a wide range of rapidly transitioned technologies including language translation, improved face shields, sniper detection, and cave-clearing robotic technologies.

Furthermore, we continue to push the envelope across the full spectrum of science, technology, and analysis for the Army. For example, ARL is providing critical analytic and technical support to the Project Manager (PM), Brigade Combat Team in developing and fielding the Stryker vehicle. ARL's contributions include assessments of Stryker survivability from the full spectrum of battlefield threats, identification of technology insertions for survivability enhancements, human figure modeling to examine C-130 transportability, and human-systems integration assessments.

## Warfighter Capabilities

The Army's Future Combat Systems (FCS) will bring unprecedented capabilities to the warfighter. ARL is developing technologies such as active protection against kinetic energy penetrators and lightweight armor/structures to defeat medium caliber threats for integration into the FCS by the U.S. Tank-automotive Research, Development and Engineering Center (RDEC).

In addition to the advent of the FCS will be major enhancements to Land Warrior. For the Objective Force Warrior, ARL materials for new lightweight, flexible body armors and sensors for detection and identification of chemical and biological threats will be provided to the Army Natick Soldier Center.

Future weapon systems being developed by the Armaments RDEC, Picatinny Arsenal, NJ, and the Aviation and Missile RDEC, Redstone Arsenal, AL, will incorporate our technologies for novel lethal mechanisms, advanced energetics and insensitive propellants, smart munitions, directed energy, and electromagnetic guns.

## Advanced Sensors And Devices

The next generation of advanced sensors and electronic devices being developed by the Communications-Electronics RDEC, Fort Monmouth, NJ, will be integral to future Army weapons and surveillance and reconnaissance systems. ARL technologies in electro-optics, microwaves, radio frequency (RF), and acoustics will enable that next generation of sensors. Our research in nanotechnology, photonics, and micromechanical devices will allow for that next generation of electronic devices.

The capability of the Army's command, control, communications, computers, and intelligence (C4I) system to provide decision supremacy and enhanced survivability through decisive engagements will be enabled by our technologies for

*ARL Within*
the Objective Force

KE Active Protection
Soldier Protection
Signature Management
Lightweight Multi-Functional Armors
Multi-Role ETC Armament
Warheads and Penetrators
Electromagnetic Gun
Unmanned Ground Vehicles
Networked Microsensors
EO and RF Sensors
Autonomous Sensing
Survivability & Lethality Analysis
MANPRINT

Biotechnology
Nanotechnology
Quantum Computing
Power and Energy
Collaborative Performance
Auditory Research
Cognitive Engineering

KE: kinetic energy
ETC: electrothermal chemical
EO: electro-optic
RF: radio frequency
MANPRINT: manpower and personnel
   integration

high-bandwidth communications, advanced battlefield processing and collaboration, microscale weather, battlefield visualization, and defensive information operations.

## Other Technologies

Soldier performance will be increased by ARL technologies for enhanced solder perception and cognition, individual and team decision-making, and crew performance in complex task environments.

ARL technologies in machine perception, autonomous tactical behaviors, and soldier-machine interaction will enable unmanned ground vehicles for reconnaissance (increasing the survivability of soldiers) and logistics (unmanned convoys and small-unit mules).

Sustainability is a key consideration for the Objective Force. ARL technologies for active twist rotors will assist the Aviation Missile RDEC in significantly reducing maintenance requirements caused by rotor vibrations. ARL research programs in power and energy impact the Army across the entire spectrum of combat

and logistics operations and will provide technologies for innovative vehicle propulsive power and lightweight, reliable, efficient power for the individual soldier.

## Experimental Facilities

To execute these programs, ARL operates a unique, unparalleled, aggregate of experimental facilities. Our facilities at Aberdeen Proving Ground (APG), MD, provide laboratory and experimental capabilities for investigations in materials characterization and processing, internal

ballistics, flight motion of projectiles, terminal ballistics, explosive mechanics and blast, and effect of soldier loads on physiologic and cognitive abilities. Our recently completed Tactical Environment Simulator allows us to immerse a soldier into a full audiovisual and pseudo-mobile environment for characterization of the cognitive and sensory perception issues associated with FCS and Land Warrior. Our Adelphi Laboratory Center facilities provide us the ability to deposit, etch, and characterize a wide range of materials through the use of six molecular beam epitaxy systems, a full suite of microanalysis tools, and clean-room space that is populated with the latest in silicon, III-V, and II-VI semi-conductor processing equipment. This enables new research into nanoscale devices, microelectro-mechanical systems for radio frequency and power applications, wide bandgap power electronics, fuel cells, and opto-electronic devices. Experimental facilities at APG and White Sands Missile Range (for acoustic and seismic characterization, missile flight simulation, electronic environment characterization and monitoring), and evaluation of the effects of munitions on aircraft support analyses of the survivability and lethality of Army materiel.

ARL operates one of four DOD High Performance Computing Centers, providing us the ability to perform the massive, highly complex, computationally intense calculations requisite to achieving the Objective Force.

## Partnerships

ARL's ability to draw from internal and external sources of diverse and high-quality research talent allows us to fulfill the Army's science and technology (S&T) needs. Our research staff of more than 1,250 research scientists and engineers (more than 32 percent with doctoral degrees) focuses our in-house research on capabilities not available in the private sector. However, researchers at ARL have long recognized that they cannot do it alone.

Through ARO, ARL capitalizes on the research capabilities of academia. The Single Investigator Program, supporting more than 600 academic researchers and 1,500 graduate students per year, provides the venue for innovative explorations along multiple pathways. University Affiliated Research Center initiatives are focused on S&T issues of critical importance. Examples of these include the Institute for Advanced Technology at the University of Texas-Austin, the Institute for Soldier Nanotechnology at the Massachusetts Institute of Technology, and the soon-to-be-established Institute for Biotechnology. ARL also awards DOD Multidisciplinary University Research Initiatives for efforts such as nanoscale scavengers and sensors, learning-based control, and computer infrastructure protection and software.

To fuse the efforts of both academia and industry, ARL's Collaborative Technology Alliances (CTAs) are government, industry, and academic research partnerships focused on Army transformation technologies wherein the expertise resident in the private sector can be leveraged to address key Army challenges. There are five CTAs: power and energy; advanced sensors; communications and networks; advanced decision architectures; and robotics. The alliances include participation from Army RDECs, other Service labs, and other DOD and U.S. government agencies.

We rely on our partnerships with the RDECs to ensure rapid transition of research from the laboratory to the field. Fifty percent of our research programs are focused on near- and mid-term challenges identified by the RDECs. The other 50 percent of our research programs are focused on the Army's long-term scientific challenges—an investment in the future. Our partnerships with the RDECs will be further strengthened and emphasized as RDECOM is fully established.

## Conclusion

The Army has embarked on an ambitious transformation journey; ARL is aware of its role in that journey. ARL is committed to delivering scientific discoveries, technologic advances, and analyses to provide warfighters with capabilities to execute full-spectrum operations. The ARL research team, its partnerships and collaborations, its research facilities, and its total commitment to the mission are all focused on delivering the motto emblazoned on our unit crest, "Technology to Win."

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